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ABSTRACT

A description of the Didactor, a "computer-type teaching machine," is given. Also included are results of a comparison of student test results for Didactor-taught and control groups receiving instruction through an audio-tape tutorial mode. (MK)

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THE DIDACTOR: A TECHNOLOGICAL AID FOR EFFECTIVE LEARNING

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ABSTRACT

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THE DIDACTOR: A TECHNOLOGICAL AID FOR EFFECTIVE INSTRUCTION

The desirable concerns of efficiency and economy coupled with the pedogogical ideal of mastery learning can be effectively obtained through utilization of the Didactor. The Didactor, a technological aid which provides many of the advantages of computer-assisted instruction, permits numerous programing techniques, offers opportunities for frequent learner responses, provides immediate feedback, monitors learning progress, compensates for learner errors, and allows learner progress adjusted to need and ability.

Analysis under controlled conditions revealed that the Didactor significantly contributed toward increased cognitive achievement at the knowledge, comprehension, and application levels. Adroitly programed, the Didactor is capable of enhancing the development of problem solving skills. Learner appraisal of Didactor facilitated instruction was reassuring.

Introduction

The Didactor is a teaching aid which provides a practical and economic approach to computer-assisted instruction. This computer-type teaching machine accommodates a high level of instructional sophistication while shifting instructional emphasis to student learning and monitoring cognitive progress with compensation for errors. The Didactor presents branched programed learning materials, delivers information in small steps, offers an opportunity for frequent student responses, gives immediate feedback, and permits progress adjusted to need and ability. The Didactor program which is presented to the student is dependent upon programer strategy and creativity as well as student responses.

Unsprocketed 35 mm photographic film contains the programed learning materials to be viewed by the learner placed side by side with the coded information which directs the Didactor's operative mechanism. As many as 300 frames of coded learning materials can be incorporated on a Didactor filmstrip and each frame can provide a maximum of five multiple choice responses.

Because of the unique qualities of the Didactor, a programed filmstrip can be presented to the student in a branched design. Since each student is directed through the program according to his own responses, few students will ever proceed through a given program in exactly the same way. A student who learns rapidly will tend to follow the mainstream of the program. A student who experiences difficulty will generally be detoured to the specific corrective, remedial, or supplementary material. If complete mastery of a sequence of frames is required, a Didactor memory system which "watches" the student's performance will automatically repeat the set of frames according to need. A Didactor timing device can be used to quicken the pace of learning and encourage attentiveness and concentration. For students unable to complete a program in one sitting, the Didactor indexing system allows the student to interrupt his study and return without losing his place in the program. In addition, the Didactor can be modified to accept and control a sound-mate (tape player) for audio presentations and/or a slide-mate (carousel-type slide projector) for visual presentations.

Methods

The teaching effectiveness of the Didactor as well as Didactor programs was determined by comparing student test results for Didactor-taught and control groups receiving instruction through an audio tape tutorial mode. Didactor programs were designed to replace the audio tape presentations of selected portions of three self-instructional modules. Thus, the only difference between a student in the control group, progressing through the instructional materials with only the audio tape presentation, and a student in the Didactor-taught group, progressing through the instructional materials with the audio tape presentation supplemented by the Didactor, would be the media of presentation. The decision to replace a particular module area was based upon student learning needs, complexity of the module topic, and the cognitive level of various portions of the subject matter. In the case of this study, three cognitive levels, knowledge, comprehensions, and application, were considered.

The development of each Didactor program was begun by organizing the subject matter content into an outline format.[1] The outline was developed to serve as a guide for the logical development of the program mainstream and as a guide for the structure and sequence of frames.

Intrinsic programing was the style used in the development of the Didactor programs. The basic technique of the intrinsic program was to present a relatively large quantity of information (25 to 100 words per frame) followed by a question which would permit the student to demonstrate his achievement.[2,3] Correct responses were reinforced in two ways. The first and most frequently used form of reinforcement was to offer a single word of affirmation as the initial word of the subsequent frame, for example, "O.K." or "FINE." The positive affirmation was usually not a superlative word or phrase because prior to any given frame, the student may have been making errors and an affirmation such as "VERY GOOD" would not be appropriate. The alternate method of reinforcement was to inform the student his response was correct, usually with an "O.K." and then elaborate upon the logic underlying the correct response. For example.

> O.K. Though the menstrual cycle involves the pituitary gland, ovary, and uterus, it is the hormone secretions of the pituitary gland, Follicle Stimulating Hormone (FSH), as well as the secretions of the ovary, estrogen and progesterone, which are responsible for the events of the menstrual cycle . . .

Incorrect responses were followed by a reprimand, "NO," and an explanation redirecting the student's logic which resulted in the incorrect answer. For example,

> NO. The answer to the previous question is 14 days because the number of days between the day of ovulation, the 14th day, and the last day of a 28 day cycle is 28 − 14 = 14.

In the development of each Didactor program or program section, the mainstream frames were written first. The major concern underlying the writing of a frame was to be concise because (1) the number of words (typewriter characters) that could be carried on a frame were limited and (2) the student's time involvement was highly valued. Also, illustrations were frequently used to enable a compact presentation. Additional concerns in the development of each program included using a conversational approach whenever possible, anticipating student misconceptions, writing significant questions, and finding logical wrong answers for questions designed to check the progress of the student. An additional concern underlying the writing of mainstream frames was to be creative, imaginative, and innovative. After the mainstream frames were written, the corrective frames were designed and the program strategies were finalized.

In providing corrective information, the programer must be incessantly alert to the intended level of cognitive achievement and the subsumption requirements as well as the state of student attentiveness. Thus, if knowledge were the intended cognitive level, then correction for errors would be the same for any question foils that were presented. However, if higher order learning were to be achieved, then correction would be specifically designed for each foil which was structured to differentiate degrees of understanding or cognitive ability. Thus, one question foil was designed to tease out incomplete understanding demanding a particular correction. On the other hand, alternate foils were structured to uncover other likely or possible misunderstandings for which corresponding correction was provided.

Now, considering the subsumption requirements a programer has several options. The most commonly employed option was to either provide correction for an error and have the student continue in the mainstream or have the student repeat the frame after correction for the error was provided. A variation of the latter strategy was to have the student go back two or more frames if it were felt that the error was indicative of an earlier misunderstanding. For example, an incorrect response to a question in frame five would receive correction in frame six. Following the correction of frame six, the student was

returned to frame two where the basic principle of the concept was established. He or she would also have to repeat frames three and five. This technique is detailed in Figure 1, Programing Flow Chart.

Another variation of frame repetition would occur if the incorrect choice could be interpreted either as a careless error or an error founded in a lack of understanding. The student was given an opportunity to select from alternatives, go on, try the last frame again, or go back to the frame initiating the concept. The following is an example of this technique.

> NO. You missed the question. Can you figure out why? If you would like to try the question again, Press A. If you inadvertantly selected the wrong choice and would like to go on, Press B. If you are experiencing difficulty in visualizing the events in the process of neuralation, it is desirable for you to review the process from the beginning, Press C.

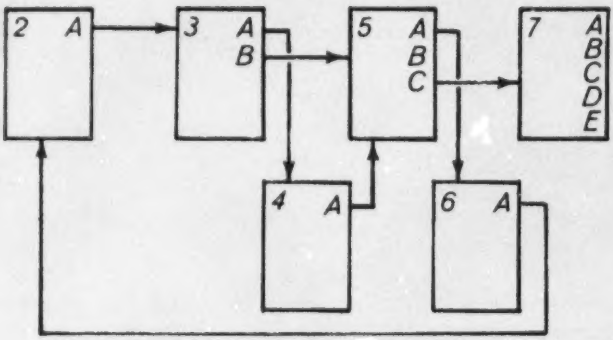

FIGURE 1, Programing Flow Chart

In some cases a program error could result if the attentive state of the student had unfortunately lapsed. A correction for an error assumed to result from a lack of attending behavior was both prefaced and concluded by more energetic comments and/or exclamations. For example,

> Oh, come on. Get with it. If red stem color is the dominant expression of a trait because it overrides or "suppresses" the alternate expression, then the alternate expression cannot be called dominant. Now, try again.

Other programming strategies included chaining, options for practice, paced learning, and mastery.[3,4] Chaining is a sequence of additive

program frames which was utilized when several frames were required to present an increment of information or to construct a complex concept. When using the chaining method to construct a complex concept, the program series was always initiated with a definition and/or basic element. The next frame building on this foundation required a student at the knowledge level to identify an exemplary verbal illustration depicting the basic element and/or definition. Following this would be a comprehension level multiple choice question requiring the selection of the correctly illustrated fundamental from other illustrations modified as foils. These foils were designed to incorrectly by degree depict the concept so as to test the progress of conceptual development and compensate with correction if and as needed. The multiple choice frame was then followed with one that involved as application of the fundamental subsequently leading to a related problem solving situation. Thus, the chaining program moved conceptually from a lower order definition to comparing examples through application and eventually to problem solving.

A program practice option is a method which contributes to cognitive retention. Practice series options of five to eight program frames were offered at timely intervals in the instructional programs. These practice options provided a student with an opportunity to practice with the principles just studied. And, consistent with the requirements of conceptualization, each practice series advanced from lower to high cognitive levels ultimately utilizing just learned fundamentals in problem solving. Whether chaining or practice series, the programs advanced with student awareness from basics to applications, syntheses, or evaluations.

Paced learning is a programing technique which encourages attending behavior, intensifies cognitive achievement, and also enhances problem solving skills. Increments of information were presented for a limited time such as ten or twenty seconds. If a response were made within the time period, the student either would be advanced in the mainstream or would be provided with corrective information if an incorrect response were made. If the time limit expired before a response were registered, information which refined and detailed the idea was automatically provided and a second try was required. In the paced learning situation, the student was being tested with the outcomes dependent upon an alert effort requiring involvement and concentration. Because the testing was only obvious to the student, a sense of personal responsibility to do well emerged as did the pride of accomplishment.

Mastery is a technique that forces repetition of a set of program frames which build to a single complex idea upon which other concepts depend or with which other concepts integrate. Consequently, any student errors as progress is made through a program are unacceptable. This technique also was employed when students demonstrated a certain learning reluctance regarding a specific topic. If a student progressing through a mastery sequence did make an error, the Didactor memory system was activated. With the completion of the section in which the error occurred, the student was informed that an error was made, that mastery was essential, and that the section would have to be repeated before continuation of the program would be allowed. Mastery sections were restricted to not more than five to eight mainstream frames. A sequence which is much longer becomes discouraging if the student must repeat it more than once; also, incentive to work for the expected mastery can be quickly lost.

After mainstream and correction frames for a program were written, each frame was typewritten on a four inch by six inch white card and a flowsheet was designed which designated the strategies of the mainstream-corrective frame sequence. The program and flowsheet constituting a program package were conveniently converted by Didactics Corporation, Mansfield, Ohio to the finished product.

Evaluation instruments to determine Didactor as well as Didactor program teaching effectiveness included criterion tests and student evaluation forms. The criterion tests were developed by selecting congruent and valid items from a pool of test questions that was established to determined the achievement of students who used prototype individualized instruction modules. The pool of test questions was composed of items written to be congruent with behavioral objectives identified as goals for student accomplishment. Each criterion test item was of multiple choice format having one correct answer mixed with four foils. Congruence was confirmed by a three member panel of subject matter experts. And, validity was a point-biserial correlation between the item and the total test score. A minimum acceptable validity was established at 0.25. Lastly, the validity standards for the criterion tests were set to at least meet if not exceed the minimum standards established by Ebel.[5] Control and Didactor-taught groups were given identical criterion tests to determine their respective achievement of objectives. Test item analysis data was tabulated and analysis of covariance of test scores of both groups was used to assess the effectiveness of the Didactor as a technological aid for instruction.

Student evaluation forms were designed to appraise program correlation with instructional materials, program difficulty, program effectiveness, and Didactor operating difficulty. Didactor-taught students were asked to respond to these assessment inventories immediately after completing their achievement tests. Opinion results for each appraisal item were tabulated and response percentages were calculated.

Results

Data analysis shown in Tables I and II indicates significantly greater achievement for the Didactor-taught group. This achievement gain can be directly attributed to the teaching capabilities of the Didactor as well as the Didactor program package. The cognitive level of teaching effectiveness of the Didactor and Didactor programs are reported in Table III. The average student achievement at the knowledge level of cognition is 87 per cent; at the comprehension level, 76 per cent; and at the application level, 75 per cent. Percentage ratings of student evaluation forms is shown in Table IV. Although slightly more than 20 per cent of the students encountered more than moderate program difficulty and about five per cent of the students encountered more than a moderate amount of difficulty in operating the Didactor, the student ratings are reassuring. A high percentage of students consider the Didactor programs to have a high correlation with the self-instruction material and to be highly effective as aids in understanding the instructional materials.

Conclusions

The Didactor is a teaching instrument that can significantly enhance learning because it has the capability of placing the student in a meaningful and attending learning environment. An explanation for the enhanced learning mediated with the Didactor is that the Didactor provides corrective explanations for student errors as the student understandings are periodically monitored. Although a student may replay an audio tape presentation, repetition does not insure clarification; the student is not provided with additional explanations from different perspectives.

The Didactor is an efficient agent in teaching problem solving. Skillful problem solving ability requires the recollection and the understanding of facts and/or rules as well as their application. Evidence indicates that the Didactor has the capability of facilitating high learning achievement at the knowledge, comprehension, and application levels which are essentials of problem solving cognition.

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TABLE I

Net Student Achievement Comparing Didactor-Taught and Control Group Objectives

Module	Control		Didactor-Taught	
	Number of Students	Mean	Number of Students	Mean
I	64	6.48	50	6.64
II	65	2.85	51	3.23
III	56	5.64	38	6.42

TABLE II

Analysis of Covariance for Didactor-Taught and Control Group on Module Achievement (Covariate: Total SATV and SATM)

Module	Source of Variance	df	SS	MS	F
I	Between Groups	1	0.69	0.69	0.312
	Within Groups	111	244.57	2.20	
	Total	112	245.26		
II	Between Groups	1	3.87	3.87	5.212*
	Within Groups	113	83.88	0.74	
	Total	114	87.75		
III	Between Groups	1	13.28	13.28	7.192+
	Within Groups	91	168.05	1.85	
	Total	92	181.33		

*significance coefficient at 0.025 = 5.14
+significance coefficient at 0.01 = 6.64

TABLE III

Cognitive Level Didactor Teaching Effectiveness

Module	Objective Cognitive Level	Test Item Validity	Student Achievement (%)
I		.60	90
	Knowledge	.53	96
		.32	78
		.46	54
		.26	98
	Comprehension	.33	98
		.38	52
		.28	58
	Application	.43	64
II		.34	92
		.45	69
	Knowledge	.25	67
		.20	96
III	Comprehension	.20	95
		.56	84
		.54	92
		.63	82
		.44	92
	Application	.69	87
		.54	71
		.51	40

TABLE IV

Student Rating of the Didactor and Didactor Programs

Module	Characteristic	Per Cent Rating				
		Very High	High	Moderate	Low	Very Low
I	Program Difficulty		10	40	34	16
	Level of difficulty encountered in operating the Didactor		8	18	38	36
	Effectiveness of the program as an aid to understanding the material	28	62	10		
	Correlation of the program with the self-instruction material	44	52	4		
II	Program Difficulty	2	16	37	19	26
	Level of difficulty encountered in operating the Didactor	2	2	6	19	71
	Effectiveness of the program as an aid to understanding the material	18	59	19	4	
	Correlation of the program with the self instruction material	31	55	14		
III	Program Difficulty		40	40	20	
	Level of difficulty encountered in operating the Didactor		3	8	30	59
	Effectiveness of the program as an aid to understanding the material	18	50	29	3	
	Correlation of the program with the self-instruction material	34	55	11		